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# Standard Test Method for Determining the Virus-Eliminating Effectiveness of Hygienic Handwash and Handrub Agents Using the Fingerpads of Adults[1]

This standard is issued under the fixed designation E1838; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## INTRODUCTION

Hands play an important role in the spread of many viruses. Thus, proper and regular hand hygiene is crucial in preventing such spread, particularly in health-care settings, day-care centers, and food-handling establishments. Many viruses that are known to spread through contaminated hands can remain infectious for several hours on human hands, and also may be more resistant than the bacteria commonly used to evaluate the microbicidal activity of handwash and handrub agents (**1**, **2**, **3**, **4**).[2] Contaminated hands also can readily transfer infectious virus to other surfaces (**1**, **2**, **3**). Hand antisepsis has been shown to interrupt the spread of viral infections (**5**, **6**, **7**, **8**, **9**). ~~Standardized methods~~ This test method is to assess the virus-eliminating potential of handwash and handrub agents ~~*have not*~~ *in vivo*.~~been available and this test method addresses the gap.~~

## 1. Scope

1.1 Human skin is not known to carry viruses as a part of its resident ~~microbiota.~~ microbiota, with the notable exception of papilloma viruses (**10**). Hands transiently contaminated with viruses can, however, act as vehicles for the spread of many types of viral infections. Hand hygiene is meant to reduce the load of viruses and other transient microorganisms on hands, thereby reducing the risk of disease transmission. Such reductions in the virus load may be due to a combination of virus inactivation and mechanical removal of infectious virus from the skin.

1.2 This test method is designed to determine the comparative virus-eliminating effectiveness of microbicidal or non-microbicidal formulations. This test method is not meant for use with surgical hand scrubs or preoperative skin preps.

NOTE 1—The test method should be performed by persons with training in virology in facilities designed and equipped for work with infectious agents at biosafety level 2 (**6**11).

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[3]

E2011 Test Method for Evaluation of Hygienic Handwash and Handrub Formulations for Virus-Eliminating Activity Using the Entire Hand

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[1] This test method is under the jurisdiction of ASTM Committee E35 on Pesticides, Antimicrobials, and Alternative Control Agents and is the direct responsibility of Subcommittee E35.15 on Antimicrobial Agents.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this standard.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E2276 Test Method for Determining the Bacteria-Eliminating Effectiveness of Hygienic Handwash and Handrub Agents Using the Fingerpads of Adults

E2613 Test Method for Determining Fungus-Eliminating Effectiveness of Hygienic Handwash and Handrub Agents Using Fingerpads of Adults

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *Health-care personnel (HCP), n*—persons who are directly related to provision of health care services. It includes all paid and unpaid persons working in health-care settings, such as physicians, nurses, nursing assistants, therapists, technicians, emergency medical service personnel, dental personnel, pharmacists, laboratory personnel, autopsy personnel, students, trainees, and contractual staff, etc., who have the potential to get themselves exposed to patients and infectious materials.

3.1.2 *hygienic (health-care personnel) handwash agents, n*—agents generally used for handwashing by personnel in hospitals, other health-care facilities, day-care centers, nursing homes, and food-handling establishments should be safe for repeated use, nonirritating, fast-acting, and efficient in eliminating transient microorganisms from intact skin.

3.1.3 *nonmedicated soap, n*—a soap or detergent that is mild to the skin and does not contain any ~~germicidal~~microbicidal chemicals.

3.1.4 *soil(organic) load, n*—a solution of one or more organic and/or inorganic substances added to the suspension of the test organism to simulate the presence of body secretions, excretions or other extraneous substances.

3.1.5 *virus-eliminating (killing/removing) agent, n*—any agent that rids hands of viruses by either killing them on the skin or by dislodging them for subsequent wash-off.

3.1.6 *virus inactivating agent, n*—any agent that renders a virus noninfectious.

## 4. Summary of Test Method

4.1 This test method is conducted on a group of adult subjects who have provided informed consent and the skin of whose hands has been determined to be free from any apparent damage. The subjects are to refrain from using any products containing antimicrobial agents for at least one week prior to the test. A known volume of the test virus suspension is placed on a demarcated area on each fingerpad and the inoculum allowed to dry. The contaminated area then is exposed to ~~the control (standard hard water) or test agent~~ test or control agent or a vehicle (for example, standard hard water), and rubbed with a randomly chosen fingerpad from the opposite hand for the desired contact ~~time and virus~~ time. Virus remaining on the ~~fingerpad~~fingerpads is then eluted and the eluates titrated for infectious virus along with the required controls. ~~Percent and/or~~The infectious units from the two thumbpads or the pair of the fingerpads that were involved in a single treatment will be averaged. Percent or $\log_{10}$ ~~reductions~~ reductions, or both, in the levels of infectious virus after treatment with the ~~control and test~~test or control agents are then determined. ~~The fingerpad method gives results that are comparable to those obtained using a whole-hand procedure (2, 7), another ASTM standard (Test Method E2011).~~ If two different formulations are being compared in the same test, one of them may be designated as a ~~reference and used in place of the hard water control.~~ reference. If desired, one also may use tap water in parallel with the hard water control to determine the influence of water hardness on the test product's virus-eliminating activity.

## 5. Significance and Use

5.1 This *in vivo* procedure is designed to test the ability of hygienic handwash and handrub agents to reduce levels of selected infectious viruses from experimentally contaminated fingerpads of adults. Since the two thumbpads and all eight fingerpads can be contaminated with virus and used in ~~any~~a given test, it allows for the incorporation of ~~input virus control (two), virus remaining viable after the inoculum has been allowed to dry (two), virus eliminated after treatment with a control or reference solution (two),~~ a wet inoculum input control, dried virus recovery control, and up to ~~four~~three replicates to assess the virus-eliminating efficiency of ~~the substance under test.~~ a test or control agent, or a vehicle material. No more than 100 µL of the virus suspension are required to complete one test. ~~The results of testing with this test method may form the basis for further tests using a suitable whole-hand test protocol (for example, Test Method E2011).~~

5.2 This test method is designed to be performed by a trained individual, who is responsible for choosing the appropriate host system for the test virus and applying the techniques necessary for propagation and maintenance of host and test virus. For a reference text, refer to Lennette et al (**812**).

5.3 Whereas the method described here relates to testing with viruses of human origin, it can be readily adapted to work with animal pathogenic viruses as well as bacteriophages. Standard methods for working with bacteria (Test Method E2276) and fungi (Test Method E2613) are also available.

5.4 Infectious microorganisms left on hands after washing can be reduced further by drying the washed hands with paper, cloth, or warm air (**913**). A step for the drying of fingerpads after exposure to the control or test ~~substance,~~product, therefore, has not been included to avoid virus removal by the drying process itself.

5.5 This test method is not meant for use with surgical hand scrubs or preoperative skin preps.

5.6 The level of viable virus ~~on each fingerpad after the drying of the inoculum~~ in the dried inocula the control fingerpads should not be less than $10^4$ infectious units which would permit the detection of up to a 4 $\log_{10}$ reduction in the infectivity titer of the virus by the test ~~substance~~product under the conditions of this test method.

## 6. Equipment and Apparatus

6.1 *Laminar Flow Cabinet*—A Class II biological safety cabinet is required for virus work. The procedures for the proper maintenance and use of such cabinets are given in Ref (**611**).

6.2 *Incubator*—An incubator at 36 ± 1°C is needed for growing host cells and for incubating virus-infected cultures. If an open system is used for cell culture, a $CO_2$ incubator will be required.

6.3 *Positive Displacement Pipette*—A pipette and pipette tips that accurately can dispense 10-µL volumes.

6.4 *Sterilizer*—Any steam sterilizer suitable for processing cell culture media and reagents is acceptable. The steam supplied to the sterilizer must be free from additives toxic to cell cultures.

6.5 *Filter Sterilization System*—A membrane or cartridge filtration system (0.22-µm pore diameter) is required for sterilizing heat-sensitive media and solutions.

6.6 *Freezers*—A freezer at – 20± 2°C is required for the storage of fetal bovine serum and other additives for cell culture media. A second freezer at – 70°C or lower is required to store viruses

6.7 *Refrigerator*—A refrigerator at 4± 2°C for storage of prepared cell culture media and reagents.

6.8 *Timer*—Any stopwatch that can be read in minutes and seconds.

~~6.9 *Magnetic Stirrer and Magnets*—Large enough to hold a 5-L beaker or Erlenmeyer flask for preparing cell culture media or other solutions.~~

6.9 *Handwashing Sink*—A sink of sufficient size to permit subjects to wash hands without touching hands to sink surface.

6.9.1 *Water Faucet(s),* to be located above the sink at a height that permits the hands to be held higher than the elbow during the washing procedure. Faucets with electronic sensors or those that are wrist-, elbow-, knee-, or foot-operated are preferred to avoid recontamination of the washed hands.

6.9.2 *Tap Water Temperature Regulator and Temperature Monitor,* to monitor and regulate water temperature at 40 ± 2°C.

6.10 *Liquid Nitrogen Storage for Cells*—A proper liquid nitrogen container and liquid nitrogen for cryopreservation of the stocks of cell lines.

6.11 *Inverted Microscope*—An inverted microscope with 10× eye pieces and 5×, 10×, and 40× objectives.

## 7. Materials and Reagents

7.1 *Serological Pipettes*—Sterile reusable or single-use pipettes of 10.0, 5.0, and 1.0-mL capacity.

7.2 *Cell Culture Flasks*—Plastic flasks of 25 or 75-$cm^2$ capacity for culturing cells and for preparing virus pools.

NOTE 2—Each flask for growing cell monolayers can be reused ten or more times before being discarded.
NOTE 3—Plastic cell culture ware may be purchased from most laboratory supply houses.

7.3 *Cell Culture Plates, 6-well*—2.0 mL per well eluent (see 7.8) shall be added. This is used for virus elution from each thumbpad and fingerpad.

NOTE 4—Alternatively, small dishes (for example, 35mm diameter) may be used for virus elution.

7.4 *Cell Culture Media and Supplements*—Culture media and the types and ratios of supplements will vary depending on the cell line. Eagle's minimal essential medium (EMEM) with 5 to 10 % fetal bovine serum (virus- and mycoplasma-tested) is used for growing a wide variety of cells (see Note 5).

NOTE 5—Materials and reagents for cell culture may be purchased from biological supply houses.

7.5 *Soil Load:*

7.5.1 *Bovine Serum,* at a final concentration of 5 % in the virus inoculum (see Note ~~5~~6).

7.5.2 A Yeast extract/BSA/Mucin tripartite soil load, as an alternative to serum. Add 0.5 g of ~~tryptone or~~ yeast extract to 10 mL of phosphate buffer. Add 0.5 g of bovine serum albumin (BSA) to 10 mL of phosphate buffer. Add 0.04 g of bovine mucin to 10 mL of phosphate buffer. Prepare the stock solutions separately and sterilize by passage through a 0.22 µm pore diameter membrane filter, aliquot and store at either 4±2°C or −20±2°C. To obtain a 500-µL inoculum of the test inoculum, add to 340 µL of the microbial suspension 25 µL BSA, 100 µL mucin and 35 µL of ~~tryptone~~ yeast extract stock solutions. This mixture contains approximately 2 g of total protein/L, which is approximately equivalent to the protein content of a 5 % solution of fetal bovine serum.

NOTE 6—Bovine serum is unsuitable for use as an organic load when working with rotaviruses because of its rotavirus inhibitory and trypsin-neutralizing activity.

7.6 *Standard Hard Water*—~~The quality and disinfectant (for example, chlorine) residual in tap water can vary from site to site and also at different times at the same site. The use of standard hard water, therefore, is recommended here to avoid variations in results due to differences in tap water quality. Water~~ Standard hard water prepared in accordance with AOAC 960.09 *E* and *F* (~~10~~14) ~~to~~at a ~~standard~~ hardness of 200 ppm as calcium carbonate is used for dilution of test substance, as the control solution to determine the baseline level of virus elimination, and to rinse the fingerpads after exposure to the test product. The standard hard water and tap water (if used) must first be tested to ensure that they do not have any virucidal activity against the test virus(es).

NOTE 7—The quality and disinfectant (for example, chlorine) residual in tap water can vary from site to site and at different times at the same site. The use of standard hard water, therefore, is recommended here to avoid variations in results due to differences in tap water quality.

7.7 *Test ~~Substance~~—product*—~~At least two~~ Two separate manufacturer's lots of the ~~substance shall~~ test product may be tested. For handwash products that are used with water, prepare a 25 % solution by adding 1 part product to 3 parts standard hard water. This dilution is necessary because water is used when the product is applied.

7.8 ~~*Diluent*~~*Eluent for Virus ~~Titration~~—Recovery from Fingerpads*—Minimum Essential Medium (MEM) + 2 % Fetal Bovine Serum (FBS), or Earle's balanced salt solution (EBSS) with a pH of ~~7.2 – 7.4~~.7.2 – 7.4, or equivalent.

7.9 ~~*Eluent*~~*Diluent for Virus ~~Recovery from Fingerpads~~—Titration*—~~EBSS (pH 7.2–7.4).~~Same as the Eluent for Virus Recovery from Fingerpads.

7.10 *Plastic Vials*—Sterile screw-capped 2.0-mL vials with an inside diameter of about 8 mm are required for demarcation of the fingerpads and to hold various test solutions.

7.11 *Miscellaneous Laboratory Ware*—Automatic pipettes, pipette tips, plastic vials for storing cell and virus stocks, dilution tubes, cluster plates, or flasks for virus titration.

## 8. Test Viruses and Cell Cultures

8.1 See Appendix X1 for recommended viruses and their host cells.

## 9. Subjects

9.1 Recruit a sufficient number of healthy ~~adult~~ human ~~volunteers~~subjects who have no clinical evidence of dermatoses, open wounds, or other skin disorders (see 4.1). The number of ~~volunteers~~subjects required for a trial is dependent on the number of treatments within a study.

9.2 It is the responsibility of the user of this test method to arrange the necessary clearance for the use of adult subjects for testing and to obtain informed and written consent from those selected for the study before starting the tests.

## 10. Procedure

10.1 ~~Fig. 1 shows the main steps for this test method. It is recommended that virus from the two thumbpads be eluted simultaneously. The simultaneous exposure and elution of the two fingerpads to be used for the control or test substance is also recommended.~~The subject will wash his/her hands with a nonmedicated soap for at least 10 s, rinse, and then dry them thoroughly with a clean paper or cloth towel.

NOTE 8—This procedure reduces variability in the test results by removing accumulated oil and dirt from the hands.

10.2 ~~The subject will wash his/her hands with a nonmedicated soap for at least 10 s, rinse, and then dry them thoroughly with a clean paper or cloth towel. This procedure reduces variability in the test results by removing accumulated oil and dirt from the hands.~~ Place about 5 mL of 70 % (v/v) ethanol in the palm of one of the washed hands and instruct the subject to rub it well over the entire surface of both hands until the alcohol and water have evaporated ~~completely (Step 1).~~completely.

10.3 Press a thumbpad or fingerpad over the mouth of an empty plastic vial (see 7.9) to demarcate the area to receive the test virus ~~inoculum (Step 2).~~inoculum.

10.4 Using a positive displacement pipette, deposit 10 µL of the virus suspension, with or without a soil load, at the center of each demarcated area ~~(Step 3).~~of both thumbpads and all eight fingerpads.

10.5 ~~It is recommended that thumbpads be used~~ Use thumbpads to determine the ~~amount~~level of infectious virus placed in each demarcated area ~~(Input~~ (Wet Inoculum Input Control). Once thumbpads have been contaminated, do not allow the inocula on them to dry and immediately elute them in accordance with ~~10.11~~10.10.

10.6 Allow the inoculum on all fingerpads to become visibly dry under ambient ~~conditions (Step 4).~~ conditions. This will generally take 15 to 30 min.

10.7 To determine the ~~amount~~level of virus remaining viable after this drying period, elute the virus simultaneously from the two ~~randomly selected~~ little fingerpads in accordance with 10.11 ~~(see Step 8 below).~~. This is the Dried Virus Recovery Control.

NOTE 9—Using the little fingerpads for the Dried Virus Recovery Control serves as a worst-case scenario

~~10.8 Expose the dried inoculum on the required number of randomly selected fingerpads, by placing 1.0 mL of the in-use dilution of the test product, control, or reference solution in a plastic vial (7.9). Place a virus-contaminated fingerpad over the~~